

CLAIMS

We claim:

1. A monolithic integrated circuit comprising:
 - a first subcircuit;
 - a second subcircuit; and
 - a bias current supply coupled to the first and second subcircuits including
 - a first bias circuit coupled to and to supply bias current to the first subcircuit, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to indicate that the bias current is to start or stop being supplied to the first subcircuit, and
 - a second bias circuit coupled to and to supply bias current to the second subcircuit.
2. An integrated circuit as described in claim 1, wherein the first and second subcircuits to operate during mutually exclusive time periods.
3. A monolithic integrated circuit comprising:
 - a substrate;
 - a first set of one or more subcircuits on the substrate;
 - a second set of one or more subcircuits on the substrate; and
 - a bias current supply coupled to the first and second sets to provide bias current to the first and second sets, and including:
 - a first bias circuit on the substrate coupled to and to supply bias current to a first subcircuit of the first set, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to

indicate that the bias current is to start or stop being supplied to the first subcircuit.

4. An integrated circuit as described in claim 3, wherein the first and second sets of subcircuits are to operate during mutually exclusive time periods.
5. An integrated circuit as described in claim 3, wherein the first and second sets comprise metal oxide semiconductor transistors.
6. An integrated circuit as described in claim 5, wherein the first and second sets comprise metal oxide semiconductor transistors in a CMOS configuration.
7. An integrated circuit as described in claim 3,
 wherein the integrated circuit is for operation as a radio transceiver including a receiver and a transmitter,
 wherein the transmitter includes the first set of subcircuits and the receiver includes the second set of subcircuits, and
 wherein the first set of subcircuits includes a power amplifier in the transmitter.
8. An integrated circuit as described in claim 7, wherein the radio transceiver is for operation in a mode having mutually exclusive transmit and receive time periods, and wherein the first switch input is to turn the power amplifier on or off for respectively operating or not operating in a transmit period.
9. An integrated circuit as described in claim 8, wherein the bias current supply further includes:
 a second bias circuit on the substrate coupled to and to supply bias current to a second subcircuit of the second set, and
 a third bias circuit on the substrate coupled to and to supply bias current to a third subcircuit of the first set, the third bias circuit including a third current modulator having the first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input additionally to indicate that the bias current is to start or stop being supplied to the third subcircuit.

10. An integrated circuit as described in claim 9, wherein the second bias circuit includes a second current modulator having a second switch input to control the rate of change of supplied bias current in response to the second switch input, the second switch input to indicate that the bias current is to start or stop being supplied to the second subcircuit.
11. An integrated circuit as described in claim 9, wherein the first and third bias circuits are to start supplying bias currents to the first and third subcircuits after different delay times from when the first switch input indicates to start supplying bias current to the first and third subcircuits.
12. An integrated circuit as described in claim 8, further comprising:
 - a first oscillator circuit on the substrate for operation at a first frequency,wherein the first current modulator is to control the rate of change of supplied bias current such that perturbations of the first frequency are reduced compared to the bias current to the first subcircuit being turned on or off substantially instantaneously in response to the first switch input.
13. An integrated circuit as described in claim 12, further comprising:
 - a second oscillator circuit on the substrate for operation at a second frequency,wherein the first current modulator is to control the rate of change of supplied bias current such that perturbations of the second frequency are reduced compared to the bias current to the first subcircuit being turned on or off substantially instantaneously in response to the first switch input.
14. An integrated circuit as described in claim 3, wherein the first current modulator is a ramp generator such that the bias current supplied to the first subcircuit approximates a ramp function in time following the first switch input indicating that the bias current is to start or stop being supplied to the first subcircuit.
15. An integrated circuit as described in claim 3, wherein the ramp function is specified by a selected delay from the first switch input indication, a selected rise time, and a selected maximum bias current.

16. An integrated circuit as described in claim 3, wherein the second bias circuit includes a second current modulator having a second switch input to control the rate of change of supplied bias current in response to the second switch input, the second switch input to indicate that the bias current is to start being supplied to the second subcircuit, wherein the first and second subcircuits operate at mutually exclusive time periods.
17. In a monolithic integrated circuit, a method of providing bias current comprising:
partitioning at least part of the integrated circuit into a first set of one or more sub-circuits and a second set of one or more sub-circuits, such that the first set and second set operate in mutually exclusive time periods;
providing bias current to the first set of subcircuits, including switchably providing bias current to one or more subcircuits of the first set only for period of operation of the first set of subcircuits; and
providing bias current to the second set of subcircuits,
the switchably providing including controlling the rate of change of supplied bias current during the switching on or off of bias current.
18. A method as described in claim 17, wherein the integrated circuit includes an oscillator operating at a nominal frequency, and wherein controlling the rate of change of supplied bias current during the switching on or off of bias current is to limit perturbations to the oscillator nominal frequency.
19. A method as described in claim 18,
wherein the integrated circuit is for operation as a radio transceiver including a receiver and a transmitter,
wherein the transmitter includes the first set of subcircuits and the receiver includes the second set of subcircuits, and
wherein the first set of subcircuits includes a power amplifier in the transmitter.

20. A method as described in claim 18, wherein switchably providing bias current to one or more subcircuits of the first set includes:

providing a modulation function to a first programmable current generator;
driving one or more slave programmable current generators with the output of the first current generator such that the outputs of the slave programmable current generators follow a time function defined by the modulation function; and
biasing the one or more subcircuits with the outputs of the slave programmable current generators.

21. A method as described in claim 20, wherein modulation function is a ramp.

22. A monolithic integrated circuit comprising:

an oscillator operating at a nominal frequency;
a first set of one or more subcircuits;
a second set of one or more subcircuits, the first and second sets to operate during mutually exclusive time periods; and
a power supply coupled to, and to supply power to, the first and second sets and to the oscillator, the power supply including

a first bias circuit coupled to and to supply bias current to a first subcircuit of the first set, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to indicate that the bias current is to start or stop being supplied to the first subcircuit,

the control of the rate of change to limit perturbations to the frequency of the oscillator during switching on and off of the first subcircuit.

23. An integrated circuit as described in claim 22,

wherein the power supply further includes:

a main bias generator having an output that supplies a reference current;

and wherein the first bias circuit includes:

a function generator having an output and an input terminal to accept the first switch input;

a master programmable current generator with a first input coupled to the output of the main bias generator, a control input coupled to the output of the function generator, and a current output; and

a slave programmable current generator having an input coupled to the current output of the master programmable bias generator and an output coupled to the subcircuit to bias the first subcircuit.

24. A radio frequency (RF) monolithic integrated circuit comprising:

a first RF subcircuit;

a second RF subcircuit; and

a bias current supply coupled to the first and second subcircuits including

a first bias circuit coupled to and to supply bias current to the first subcircuit, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to indicate that the bias current is to start or stop being supplied to the first subcircuit, and

a second bias circuit coupled to and to supply bias current to the second subcircuit.

25. An integrated circuit as described in claim 24, wherein the first and second RF subcircuits to operate during mutually exclusive time periods.

26. A monolithic radio frequency (RF) integrated circuit comprising:

a substrate;

a first set of one or more RF subcircuits on the substrate;

a second set of one or more RF subcircuits on the substrate; and

a bias current supply coupled to the first and second sets to provide bias current to the first and second sets, and including:

a first bias circuit on the substrate coupled to and to supply bias current to a first RF subcircuit of the first set, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to indicate that the bias current is to start or stop being supplied to the first RF subcircuit.

27. An integrated circuit as described in claim 26, wherein the first and second sets of RF subcircuits are to operate during mutually exclusive time periods.
28. An integrated circuit as described in claim 26, wherein the first and second sets comprise metal oxide semiconductor transistors.
29. An integrated circuit as described in claim 28, wherein the first and second sets comprise metal oxide semiconductor transistors in a CMOS configuration.
30. An integrated circuit as described in claim 26,
 wherein the integrated circuit is for operation as a radio transceiver including a receiver and a transmitter,
 wherein the transmitter includes the first set of RF subcircuits and the receiver includes the second set of RF subcircuits, and
 wherein the first RF subcircuit includes an RF power amplifier in the transmitter.
31. An integrated circuit as described in claim 30, wherein the radio transceiver is for operation in a mode having mutually exclusive transmit and receive time periods, and wherein the first switch input is to turn the power amplifier on or off for respectively operating or not operating in a transmit period.
32. An integrated circuit as described in claim 31, wherein the bias current supply further includes:

a second bias circuit on the substrate coupled to and to supply bias current to a second RF subcircuit of the second set, and

a third bias circuit on the substrate coupled to and to supply bias current to a third RF subcircuit of the first set, the third bias circuit including a third current modulator having the first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input additionally to indicate that the bias current is to start or stop being supplied to the third RF subcircuit.

33. An integrated circuit as described in claim 32, wherein the second bias circuit includes a second current modulator having a second switch input to control the rate of change of supplied bias current in response to the second switch input, the second switch input to indicate that the bias current is to start or stop being supplied to the second RF subcircuit.
34. An integrated circuit as described in claim 32, wherein the first and third bias circuits are to start supplying bias currents to the first and third RF subcircuits after different delay times from when the first switch input indicates to start supplying bias current to the first and third RF subcircuits.
35. An integrated circuit as described in claim 31, further comprising:

a first oscillator circuit on the substrate for operation at a first frequency,

wherein the first current modulator is to control the rate of change of supplied bias current such that perturbations of the first frequency are reduced compared to the bias current to the first RF subcircuit being turned on or off substantially instantaneously in response to the first switch input.
36. An integrated circuit as described in claim 35, further comprising:

a second oscillator circuit on the substrate for operation at a second frequency,

wherein the first current modulator is to control the rate of change of supplied bias current such that perturbations of the second frequency are reduced compared to the bias current

to the first RF subcircuit being turned on or off substantially instantaneously in response to the first switch input.

37. An integrated circuit as described in claim 26, wherein the first current modulator is a ramp generator such that the bias current supplied to the first RF subcircuit approximates a ramp function in time following the first switch input indicating that the bias current is to start or stop being supplied to the first RF subcircuit.

38. An integrated circuit as described in claim 26, wherein the ramp function is specified by a selected delay from the first switch input indication, a selected rise time, and a selected maximum bias current.

39. An integrated circuit as described in claim 26, wherein the second bias circuit includes a second current modulator having a second switch input to control the rate of change of supplied bias current in response to the second switch input, the second switch input to indicate that the bias current is to start being supplied to the second RF subcircuit,

wherein the first and second RF subcircuits operate at mutually exclusive time periods.

40. In a monolithic radio frequency (RF) integrated circuit, a method of providing bias current comprising:

partitioning at least part of the integrated circuit into a first set of one or more RF subcircuits and a second set of one or more RF subcircuits, such that the first set and second set operate in mutually exclusive time periods;

providing bias current to the first set of RF subcircuits, including switchably providing bias current to one or more RF subcircuits of the first set only for period of operation of the first set of RF subcircuits; and

providing bias current to the second set of RF subcircuits,

the switchably providing including controlling the rate of change of supplied bias current during the switching on or off of bias current.

41. A method as described in claim 40, wherein the integrated circuit includes an oscillator operating at a nominal frequency, and wherein controlling the rate of change of supplied bias current during the switching on or off of bias current is to limit perturbations to the oscillator nominal frequency.
42. A method as described in claim 41,
wherein the integrated circuit is for operation as a radio transceiver including a receiver and a transmitter,
wherein the transmitter includes the first set of RF subcircuits and the receiver includes the second set of RF subcircuits, and
wherein the first set of RF subcircuits includes a power amplifier in the transmitter.
43. A method as described in claim 41, wherein switchably providing bias current to one or more RF subcircuits of the first set includes:
providing a modulation function to a first programmable current generator;
driving one or more slave programmable current generators with the output of the first current generator such that the outputs of the slave programmable current generators follow a time function defined by the modulation function; and
biasing the one or more RF subcircuits with the outputs of the slave programmable current generators.
44. A method as described in claim 43, wherein modulation function is a ramp.
45. A monolithic radio frequency (RF) integrated circuit comprising:
an oscillator operating at a nominal frequency;
a first set of one or more RF subcircuits;
a second set of one or more RF subcircuits, the first and second sets to operate during mutually exclusive time periods; and
a power supply coupled to, and to supply power to, the first and second sets and to the oscillator, the power supply including

a first bias circuit coupled to and to supply bias current to a first RF subcircuit of the first set, the first bias circuit including a first current modulator having a first switch input to control the rate of change of supplied bias current in response to the first switch input, the first switch input to indicate that the bias current is to start or stop being supplied to the first RF subcircuit,

the control of the rate of change to limit perturbations to the frequency of the oscillator during switching on and off of the first RF subcircuit.

46. An integrated circuit as described in claim 45,

wherein the power supply further includes:

a main bias generator having an output that supplies a reference current;

and wherein the first bias circuit includes:

a function generator having an output and an input terminal to accept the first switch input;

a master programmable current generator with a first input coupled to the output of the main bias generator, a control input coupled to the output of the function generator, and a current output; and

a slave programmable current generator having an input coupled to the current output of the master programmable bias generator and an output coupled to the RF subcircuit to bias the first RF subcircuit.